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ABSTRACT

Contemporary learning theory supports the use of writing as a cognitive tool to enhance retention and assist students to understand abstract mathematical concepts. Using writing activities in the intermediate grade and secondary classroom enhances the learning of mathematics and is a way of making mathematics more reachable to those students who have labeled themselves as math illiterates. Students can personalize practice problems provided in their text by writing a short word problem that represents the practice problem. Students can write definitions of mathematical terms in their own words to personalize the definitions. Students can prepare a written explanation of errors they make on a particular test or assignment. Each of these activities maintains a direct focus on the mathematical concept while requiring students to express themselves in writing. (RS)

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WRITING ACROSS THE CURRICULUM: MATHEMATICS

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The instructional techniques involved in implementing a writing across the curriculum program are often accepted by elementary, middle school, junior or senior high teachers who specialize in social studies and science courses. As could be expected, teachers of English and language arts are comfortable using a variety of writing activities in their own classrooms and are generally strong advocates of the use of writing in other content areas. However, acceptance of this concept is not universal among all teachers of all subject areas. In particular, mathematics teachers are often reluctant to integrate writing activities into regular classroom instruction. Some mathematics teachers have suggested that writing activities have limited application in mathematics classrooms because of the highly symbolic nature of the subject and because mathematics does not rely on lengthy text passages to communication information. This is unfortunate because contemporary learning theory supports the use of writing as a cognitive tool to enhance retention and assist students to more completely understand abstract concepts.

Two specific aspects of learning theory support the integration of writing into the instructional process. The first is the purposeful construction of mental connections between the new material and previously stored information. The formation of this schematic organization is essential to long term learning (Mayer, 1982, 1984; Bransford, 1979). A second factor essential to the learning of new information is active processing of the material (Just and Carpenter, 1987). Automatic processes, such as passive listening, are not sufficient to ensure long term retention. Active processing occurs as the learner restates information, applies information in different contexts, interprets the information in different words, and organizes the information to represent different points of view.

Requiring students to write about content material in the classroom is consistent with these two fundamental elements of learning theory. Writing requires a high level of active processing of information. Unless students are merely copying word for word from

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printed text, they are translating the new information into their own words, forming connections with previously learned information, interpreting and applying it in new contexts. Writing is also the concrete visualization of content material. The learner is not only making connections, but creating new connections while developing a personal organizational schema.

In addition to the theoretical rationale for integrating writing into mathematics instruction, there is also a practical rationale based on the characteristics of typical students and teachers. Math anxiety, math phobia and math avoidance are all widespread among students and even some mathematics teachers (Tobias, 1980). A society that abhors the inability to read and write tolerates a lack of knowledge in mathematics (Paulos, 1988). People smile in sympathetic understanding as an adult states that he/she can never accurately balance the checkbook. But those same people would be horrified if an adult stated that he/she could never accurately read a newspaper article. By the time students enter junior high school, many have come to view math as difficult and beyond comprehension. Many junior and senior high students freely admit that they "are not math people" (Tobias, 1980). Although writing is difficult for many students and teachers, it is generally viewed as a more achievable task than mathematics. Using writing activities in the mathematics classroom is not only way of enhancing the learning of mathematics, but it is also a way of making mathematics seem more "reachable" to those students who have labeled themselves as "math illiterates."

Three separate writing activities for use in the mathematics classroom are described below. Each activity is appropriate for students in the upper elementary grades, middle school, junior or senior high.

Writing Activity #1: Personalizing Practice Problems

Regardless of the grade level, a typical activity in a mathematics classroom is to ask students to solve a series of practice problems written in the text or on a worksheet. The

purpose of this activity is to provide drill and practice in the numerous math facts that students must know in order to solve more advanced problems. Often, however, students view these problems as tedious and removed from the real word. Asking students to personalize some of these problems by writing a short story, or word problem, for the math fact accomplishes two things. First, it requires the student to actively process the individual parts of the math problem. Second, it makes the math problem more concrete by forming associations with real or imaginary characters.

Example:

Solve this problem: 12 + 39 =

Fifth grade teacher's sample story: I have 12 books on the top shelf of my closet. There are 39 books on the floor of the closet. Altogether there are 51 books in my closet.

Solve this problem: 43 + 57 =

Jennifer's story: The cafeteria sold 43 hot dogs on Monday and 57 hot dogs on Tuesday. Altogether they sold 100 hot dogs on the first two days of the week.

There are several possible applications for personalizing practice problems in a classroom. The teacher could use the writing of stories to accompany specific problems as a way of drawing attention to the procedure required to complete the mathematical problem. In the example above, the mathematical procedure is carrying from the one' column to the ten's column. The necessity to learn this procedure is reinforced by the story written for the specific problem.

This activity could also be used to begin a section of review problems. Each student could select a problem to write a story about, share the stories they have written, and then complete the practice problems.

Activity #2: Definitions of Mathematics Terms

Although mathematics is a symbolic language, there are numerous terms that students need to master. For example, in an introductory geometry unit in sixth grade, students would be expected to understand terms such as triangle, cube, parallelogram, hypothenuse, angle, rectangle and square. Asking students to write definitions of these terms in their own words is one way of assisting students to personalize the definitions. For further reinforcement, students could be asked to illustrate their definitions.

For example:

Write a definition of a rectangle.

Fourth grade teacher's sample: A rectangle is a box shape that has two short sides of the same length and two longer sides of the same length.

Write a definition of an angle.

Jeremy's definition: An angle is the way you can measure how far it is between two sides of a corner.

Writing Activity #3: Error Analysis

When error analysis is used as a writing activity in mathematics classes, students are asked to prepare a written explanation of the errors they made on a particular test or assignment. This can be a valuable learning experience for students. Students are required to not only take a second look at each problem that they missed, but they are also required to determine where and how they made an error in working the problem.

The following examples were collected from seventh grade students who had been asked to write a short explanation of the reason they missed each problem that had been

marked wrong on a ten problem quiz. Students were also asked to correct the problems and then staple the error analysis to the back of the quiz.

"On #5 I multiplied 7 x 6 and got 49 instead of 42." Joelle

"I wrote down the wrong problem for #7 so I missed it." Angie

"I did a wonderful job on this test." Maria

"On problem #10 I added 3 and 5 and got 15." Mark

"I used my calculator for #4 but is was wrong." Tom

"I don't know why I missed #2 and #6 and #8." (unsigned)

This procedure can provide useful insights for teachers. In the examples above, Tom is in need of some direct instruction in the use of the calculator. Joelle, Angie and Mark have correctly identified that they made careless errors. Maria is obviously very proud of her good score. The owner of the unsigned error analysis is clearly in need of special assistance.

Each of these writing activities is based on a direct application of learning theory into the classroom environment. Each activity is appropriate for students in the upper elementary and middle school grade, as well as for junior and senior high school students. Each activity maintains a direct focus on the mathematical concept while at the same time requiring students to express themselves in writing.

Writing across the curriculum is appropriate not only in the traditional subject areas of English, language arts, social studies and science, but also in mathematics. Prose writing about content information has an essential instructional role in the mathematic's classroom.

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